MOTOROLA

May 6, 2003

Mr. Edmond Thomas
Chief, Office of Engineering and Technology
Federal Communications Commission
445 12th St., N.W.
Washington, DC 20005

Re: WT Docket No. 02-55

Dear Mr. Thomas,

Thank you for your letter dated April 18, 2003, requesting updated information relevant to the above captioned proceeding considering ways to resolve interference to public safety operations in the 800 MHz band. Motorola has been active in this proceeding, providing information on the mechanisms resulting in inference from low-site CMRS base stations to public safety receivers, on potential technical solutions to the interference, and on the challenges in implementing these technical solutions.

Motorola has continued to work to overcome these challenges and, as the record in this proceeding has developed, it appears that there are new opportunities for successfully resolving many of the instances of interference through advances in receiver technology and increased signal strength for public safety systems. Motorola believes that technical advances in receiver design are commercially viable, will have limited impact on the cost of portable public safety equipment and provide a real opportunity for alleviating interference to public safety. While we are still in the process of testing to fully understand the degree to which these advances will mitigate interference to public safety, testing and analysis to date is very promising and Motorola plans to deploy the receiver technology advancements by the end of 2003. Motorola believes that it possible to alleviate a majority of the interference being experienced through best practices and new technical solutions.

Interference to any public safety system is serious and must be proactively avoided, if possible, and dealt with as rapidly as possible when it does occur. This approach has the advantage of limiting the disruption to public safety operations to those areas that experience, or are likely to experience interference, which is relatively small compared to the 2,139 public safety systems deployed in the 800 MHz band.[1] A review of the APCO database on interference shows 24 unique customer issues in 2000, 7 in 2001, 23 in 2002, and 5 in the first quarter 2003. A total solution must include coordination between public safety and CMRS operators to identify areas where interference is likely, so that the

[1] Number of public safety systems is derived from the FCC licensing database.

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problem can be addressed before it happens. Motorola believes that the technical solutions discussed herein provide the means to do so, while not impacting the public safety systems that are not experiencing interference.

Motorola is pleased to provide the Commission with currently available information on the status of our efforts and to provide additional information as it becomes available. We would also welcome the opportunity to work with the Commission to develop as complete a solution as possible.

I. Interference is the Result of Dissimilar Systems Developed for Dissimilar Service Requirements

The interference addressed by this proceeding has developed as CMRS operators have moved from relatively high-site operations to low-site configurations that provide greater channel reuse and higher system capacity. Conversely, public safety systems are primarily deployed using high antenna heights to achieve maximum coverage for a smaller number of users. As a result of this difference in system deployment, public safety receivers in some areas experience a large relative difference between the desired signal strength of public safety systems and the undesired signal strength for CMRS operations. This large relative difference in signal strengths results in intermodulation interference, interference from out-of-band emissions, and receiver overload interference as described in your letter. The interference is exacerbated by the interleaved or adjacent channel operation of low-site CMRS systems with public safety in the 800 MHz band.

CMRS operators have recognized their responsibility to resolve the interference and have worked with public safety users pursuant to a best practices guide to resolve interference on a case-by-case basis as it occurs.[2] Seeking a proactive, longer-term solution, Nextel, working with associations that represent public safety and private radio interests, has developed a plan ("consensus plan"), which would significantly reduce the interference in the 800 MHz band by consolidating public safety use and eliminating the interleaving of CMRS channels with public safety.[3]

In developing the consensus plan, the parties recognized that eliminating channel interleaving is not sufficient to eliminate interference to non-cellular operations, but that additional procedural and technical changes are necessary. Accordingly, the consensus plan proposes that the Commission take steps to further limit the out-of-band emissions from cellular operations, that best practices continue to

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[2] The Best Practices Guide was developed in December 2000 by a working group of experts from the Association of Public-Safety Communications Officials-International, the Cellular Telecommunications & Internet Association, Motorola, Nextel Communications, and the Public Safety Wireless Network and provides guidance on avoiding interference between public safety systems and CMRS.

[3] The consensus plan was filed by a group of 17 parties on August 17, 2002. The consensus parties provided supplemental information in comments filed December 24, 2002 ("Supplemental Comments").

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be used in instances of interference, and that the Commission adopt minimum performance requirements for public safety receivers.

Significantly, the consensus plan also proposes that interference protection only be afforded to non-cellular operators, including public safety and private users, if they meet the following threshold requirements, 1) the desired signal levels at the non-cellular receive must meet or exceed –98 dBm for existing systems or –95 dBm for new systems, and 2) the users' receivers must meet the Telecommunications Industry Association ("TIA") Class A performance specifications.[4] In areas where these threshold conditions are met, the consensus agreement calls for use of best practices to resolve interference should it occur. No protection would be afforded in areas where the threshold conditions are not met and it is the responsibility of the party receiving interference to resolve interference should it occur.[5]

Limiting the areas where interference protection is afforded is a significant deviation from current practice. Motorola noted in its comments that the threshold levels of –95 dBm and –98 dBm do not correspond to the minimum expected usable signal strength of today's public safety systems.[6] The proposed criteria would require some public safety systems to increase the signal strength by approximately 8 to 11 dB from current levels to retain the right to operate "free from measurable interference."[7] In agreeing to a minimum signal strength as part of the solution for resolving interference, representatives of public safety and private radio users have significantly expanded the options available for a technical resolution. Motorola's technical advances detailed here are, in large part, a consequence of this significant agreement on increased signal strength.

II. Radio Receiver

Throughout this proceeding, CMRS carriers have challenged manufacturers to develop public safety radio receivers that offer greater immunity to interference than radios that are currently deployed.[8]

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[4] Supplemental Comments at 41 and Appendix F §§ 2.1.1 and 4.1.1b.

[5] Supplemental Comments at Appendix F § 2.2.2. Motorola notes that, while the minimum threshold level requires increasing the signal strength of public safety systems, no monies were identified to do so as part of the Consensus Agreement.

[6] Motorola comments, February 10, 2003 at 10.

[7] Consensus group supplemental comments at App. F § 2.1.1. In Motorola's February 10 comments we pointed out that limiting interference rights of public safety to areas that meet the –98 dBm and –95 dBm thresholds would reduce the protected area by 27 to 48 percent compared to the current usable signal strength of –106 dBm. Motorola comments at 12.

[8] Comments of Nextel Communications, Inc., May 6, 2002 at 6; Joint Comments of Cingular Wireless LLC and ALLTEL Communications, Inc., May 6, 2002 at 7; Comments of Cingular Wireless LLC, ALLTEL Communications, Inc., AT&T Wireless Services, Inc., Sprint Corporation, and Southern LINC, February 10, 2003 at 17.

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Carriers have focused largely on the intermodulation rejection performance of receivers and on the filter characteristics of the receivers. Motorola has provided information demonstrating that our public safety receivers already provide from 1 - 14 dB greater intermodulation rejection than radios deployed by CMRS systems.[9] Motorola has also described the negative impacts of further improving intermodulation performance at this time – primarily increased power drain resulting in unacceptable battery life for portable units.[10] With regard to use of narrower filters as proposed by some CMRS carriers, Motorola has provided information showing the increased insertion loss for narrower filters compared to filters currently employed. An across-the-board increase in insertion loss reduces the sensitivity of the radio at all times, thereby reducing public safety coverage in weak signal areas.[11]

Despite these challenges, Motorola has continued to dedicate engineering resources to respond to changing customer requirements as the radio environment in the 800 MHz band has moved from one in which predominately high-site systems were deployed to one in which public safety high-site systems must operate adjacent to and interleaved with low-site commercial systems. Implementing technical solutions proved to be daunting based on the current noise limited design of public safety systems that require reliable operation in weak signal areas. The technical solutions are not compatible with public safety's current need to operate reliably in weak signal areas.

However, based on the consensus plan, it appears that all parties recognize the need for increasing the signal strength for public safety systems to provide maximum reliability and to overcome interference. Motorola is confident that, with increased signal strength in previously weak signal areas, some of the technical solutions that Motorola has pursued are feasible and will largely mitigate the interference. These solutions can be incorporated into best practices procedures and used in the short-term to resolve interference in areas where it is experienced or where it is likely, while also providing long-term mitigation of interference.[12] This approach focuses resources and disruption in the limited number of areas where interference occurs rather than disrupting public safety operations nationwide. At the same time, this approach offers a long-term increase in the overall reliability of public safety systems.

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[9] Motorola Ex Parte filing dated October 31, 2002, at slide 20.

[10] See Original Mot comments at 20-21; letter from Al Ittner to Michael Wilhelm dated June 20, 2002; Motorola Ex Parte filing dated October 30, 2002 at slide 21.

[11] Motorola Ex Parte filed October 31, 2002, at 18.

[12] The technology will also be deployed through the normal replacement cycle of radios, however, this will take multiple years.

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At the request of the Office of Engineering and Technology, Motorola has participated in a number of discussions exploring the feasibility of resolving interference to public safety on a case-by-case basis.[13] These discussions have focused largely on increasing the desired signal strength in areas where public safety is receiving interference. While simply increasing signal strength will address interference in many cases, Motorola notes that it is often not a straightforward proposition to do so.[14] In some cases adding additional base stations can be difficult because of cost, tower construction and site leasing needs. In some areas it also will not be possible just to add an additional base station because no additional frequencies are available. In such cases, users will have to convert their systems to support simulcast operation. Adding simulcast sites creates additional intrasystem interference concerns. Motorola has taken these issues into consideration as it has explored solutions.

a. Switchable Attenuators

In its October 30, 2002 ex parte presentation to the Office of Engineering and Technology, Motorola discussed one method of addressing interference by using a switchable attenuator to reduce the strength of signals entering the receiver that would otherwise result in non-linear operation of the low noise amplifier and mixer, creating intermodulation interference. However, activating the attenuator desensitizes the radio and would result in loss of coverage in weak signal areas. Accordingly, while a switchable attenuator can be used to mitigate interference in strong desired signal areas, it is not feasible to use it at the edge of coverage for current public safety systems. One challenge of such a solution is ensuring that the attenuator is only activated in areas where the desired signal is sufficient to ensure reliable communications.

Motorola has made substantial progress in addressing the challenges of implementing a switchable attenuator in a way that reduces interference in areas of sufficient desired signal strength while ensuring that the attenuator does not degrade the reliability of public safety communications by activating when the desired signal is too low. Motorola now views this as a commercially viable feature when the public safety signal strength is sufficiently strong. Testing has shown a significant improvement in immunity to interference for portable receivers equipped with this feature over current designs.

Figure 1 shows the coverage outage level for public safety radios operating within a mile of a typical CMRS site based on the separation between a public safety site[15] and an interfering CMRS site.[16]

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[13] *See* Motorola Ex Parte filings dated September 20, 2002, and October 31, 2002.

[14] It also is not always the most effective method of addressing interference since 1 dB of increased signal strength yields 1 dB of improvement, while decreasing the interfering signal by 1 dB yields 3 dB of improvement in reducing interference.

[15] A Public Safety site is defined as having approximately 15 miles coverage radius using an APCO25 defined sensitivity of –109.9 dBm.

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The user requirement is for 95% coverage (5% outage) on the edge of the service area for a typical public safety system. Interference results largely because of a relative difference between the desired public safety signal and the undesired CMRS signal. Accordingly, the potential for interference is greatest in areas far from the public safety site, where the public safety signal is weakest, and close to a CMRS site, where the undesired signal is strongest. Radios with a higher IMR[17] are more tolerant of a difference between desired and undesired signals making it possible to increase the spacing between a CMRS base station and a public safety base station. In a noise limited environment (no interference) the size of the public safety site can typically be up to 15 miles as indicated by the green line. For radios with IMR performance of 70 dB, the percent outage increases significantly around the CMRS site as the separation between the public safety site and a potentially interfering[18] CMRS site increases. A 70 dB IMR radio will meet the target coverage (solid red line) only when potentially interfering CMRS sites are located within 3 miles of the public safety site. Potentially interfering CMRS sites within approximately 8 miles can be tolerated (solid black line) if a 75 dB IMR radio is used.

A 70 dB IMR radio that turns on 15 dB of attenuation when the desired signal is greater than -95 dBm is shown in Figure 1 as the red line with tick marks. Results indicate that the IM performance of this radio approximates the performance of 75 dB IMR radio without the attenuator. A radio with IM performance of 75 dB and a switchable attenuator that turns on 10 dB of attenuation when the desired signal level is greater than -99 dBm, indicates that potentially interfering CMRS sites within approximately 12 miles will allow the public safety users to achieve the 95% coverage criteria. The performance of a 75 dB IM portable with the switchable attenuator approximates or exceeds the level of performance experienced by Motorola's current mobile radios that meet the TIA class A 75 dB IMR parameter. Motorola is not aware of any cases of interference reported for mobile radios that meet that specification.

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[16] Motorola Ex Parte filed October 31, 2002 at 9.

[17] Intermodulation Rejection Ratio (IMR).

[18] The actual interference potential of CMRS sites varies greatly from no interference to interference so strong that multiple best practice remedies will be required to mitigate the interference.

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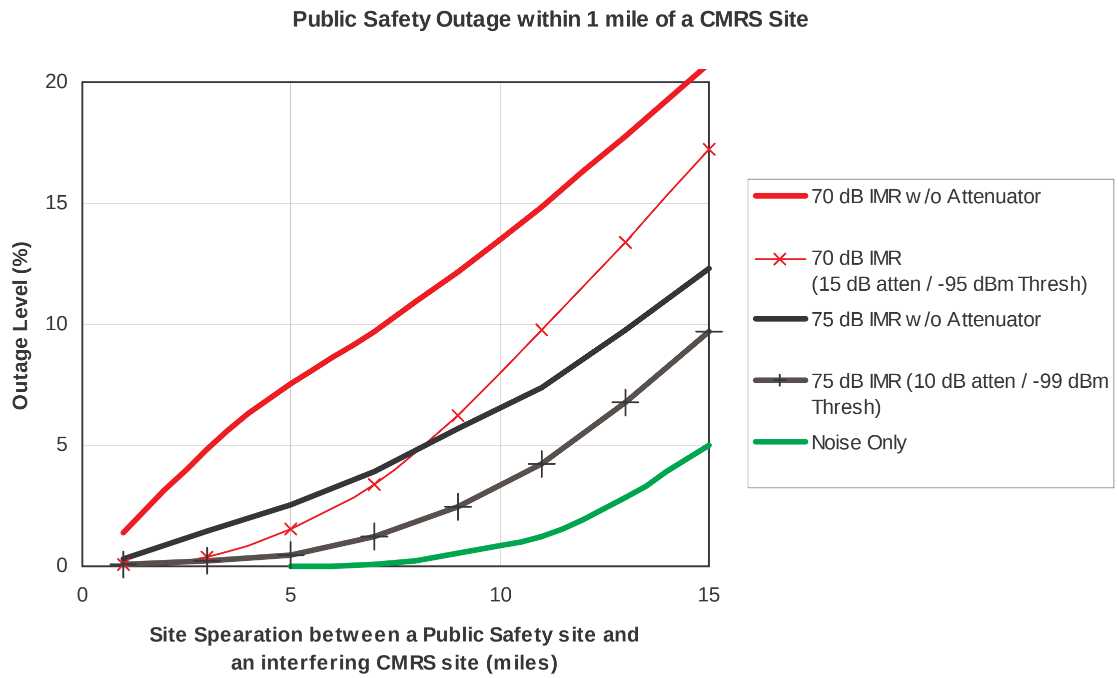

Figure 1

Motorola believes that a combination of switchable attenuators and increased public safety signal strength in weak signal areas will mitigate the interference being experienced to a large extent. Implementing a switchable attenuator solution would require replacing or retrofitting radios in areas where interference can't be resolved by other best practices. Motorola believes that a field upgrade kit could be developed for some radios. Radios with switchable attenuators will also be implemented through the normal purchasing cycle for users, raising the future overall immunity of systems to interference. Motorola expects to have radios with switchable attenuators commercially available by the end of 2003. The addition of a switchable attenuator will have only a minimal impact on the cost of receivers.

b. Tunable Varactors

Another solution that Motorola has pursued is to tune dynamically the varactor filter on its radios that operate in both the 700 MHz and 800 MHz bands. Filter performance for public safety radios has been a significant focus of some CMRS carriers, which claim that filters on newer public safety radios are unnecessarily wide and allow excessive energy from out-of-band sources into the front end of the

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radio.[19] Motorola has provided information describing the purpose of the radio filters and the performance implications of reduced public safety coverage due to higher insertion loss with narrower filters. This loss of coverage on all radios under all circumstances is unacceptable for public safety users and Motorola believes that the use of narrower filters is therefore not feasible.

However, the filters that are in radios covering both the 700 MHz and 800 MHz bands, the XTS 2500 and XTS 5000 models, are equipped with tunable filters. The filters have been tuned to maximize receiver sensitivity (low insertion loss) while preventing interference from receiver image spurs.[20] While narrowing the pass band of these filters is not feasible, Motorola has been testing new software that retunes the filter based on received signal strength. Motorola has found that, with the tunable varactor filter tuned away from the cellular radio frequencies, increasing the in-band attenuation and providing the same effect as the switchable attenuator, interference has been significantly mitigated. All of the deployed dual-band XTS 2500 and XTS 5000 model radios (which began shipping in 4th quarter 2001) are physically capable of implementing this solution, but will require additional software.

c. Improved Intermodulation Rejection Performance

Finally, Motorola has provided information to the record of this proceeding describing the superior intermodulation rejection performance of public safety radios and the consequences of significantly improving performance with currently deployed technology. Improving performance would come at the cost of increased current drain, which would shorten the usable duration of a battery to unacceptable levels – less than a full shift for a public safety user. However, as Motorola has previously stated, IMR performance has improved by 10-15 dB over the last 15 years.[21] While we do not see any reason to expect a sudden, significant improvement in performance, it is reasonable to expect the trend in incremental improvements in IMR performance to continue as technology and design advances. Accordingly, in addition to the solutions described above, the Commission could reasonably expect to see interference decrease in the future as technology continues to advance.

III. Results of Testing

Motorola is in the process of testing the solutions described above to ensure that they can be implemented in a way that mitigates interference while meeting the high reliability requirements necessary for the public safety community. Testing has been conducted in both the laboratory and the

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[19] Comments of Cingular, May 6, 2002 at 7

[20] The primary function of a receiver front-end filter is to protect the receiver from image spurs. An image spur is an undesired spurious signal with a frequency that is separated from the Local Oscillator frequency by the IF frequency. The result is a spur that is produced at the IF frequency. It is created due to the Mixer non-linearities.

[21] Reply Comments of Motorola, August 7, 2002, at 21.

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field and has focused on two areas, 1) to determine whether the solutions create any adverse behavior on the part of the receiver and, 2) to determine how effectively the solutions reduce intermodulation interference.

Motorola has previously provided information on potential adverse behavior for a solution involving a switchable attenuator.[22] Because the attenuator desensitizes the radio, it cannot be used in areas where the desired signal is relatively weak. Accordingly, proper control of attenuator switching is critical to ensuring that public safety personnel do not miss calls. It is important that the attenuator control mechanism not mistakenly activate the attenuator in an area where the undesired, rather that the desired, signal is strong. The feature must also interact properly with all of the radio features, including scanning, and system handover. Since use of these features may involve both strong and weak desired signals, the radio must be able to protect itself in strong signal areas, but remain available for weak signals when necessary. Testing also ensured that the attenuator hysteresis is properly adjusted to avoid rapid switching, particularly as the radio experiences rapid fading.

With laboratory and field testing at several sites, Motorola has gained confidence that the attenuator decision algorithm is sufficiently reliable and sophisticated enough to handle the situations described above Beta testing with customers is the next step in the evaluation of the attenuator technology. Motorola sees no significant technical problems remaining for implementation.
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The other focus of testing, determining the effectiveness of the solutions in reducing outages due to intermodulation interference, has also been very encouraging. Figure 2 shows laboratory testing of the IM rejection of several Motorola radios versus the desired signal power, all of which meet TIA Class A receiver specifications. The XTS3000 and XTS5000 are portable radios, the Astro Spectra and XTL5000 are mobile radios. The XTS5000, modified by adding an attenuator, data shows how the front-end attenuator provides significant improvement in the IM rejection when the attenuator is enabled. In fact, the portable with the attenuator turned on will exceed the IM rejection performance of mobile radios. Motorola is not aware of any CMRS interference issues with mobile radios that meet TIA Class A receiver requirements.

[22] Motorola Ex Parte, Oct. 31, 2002.

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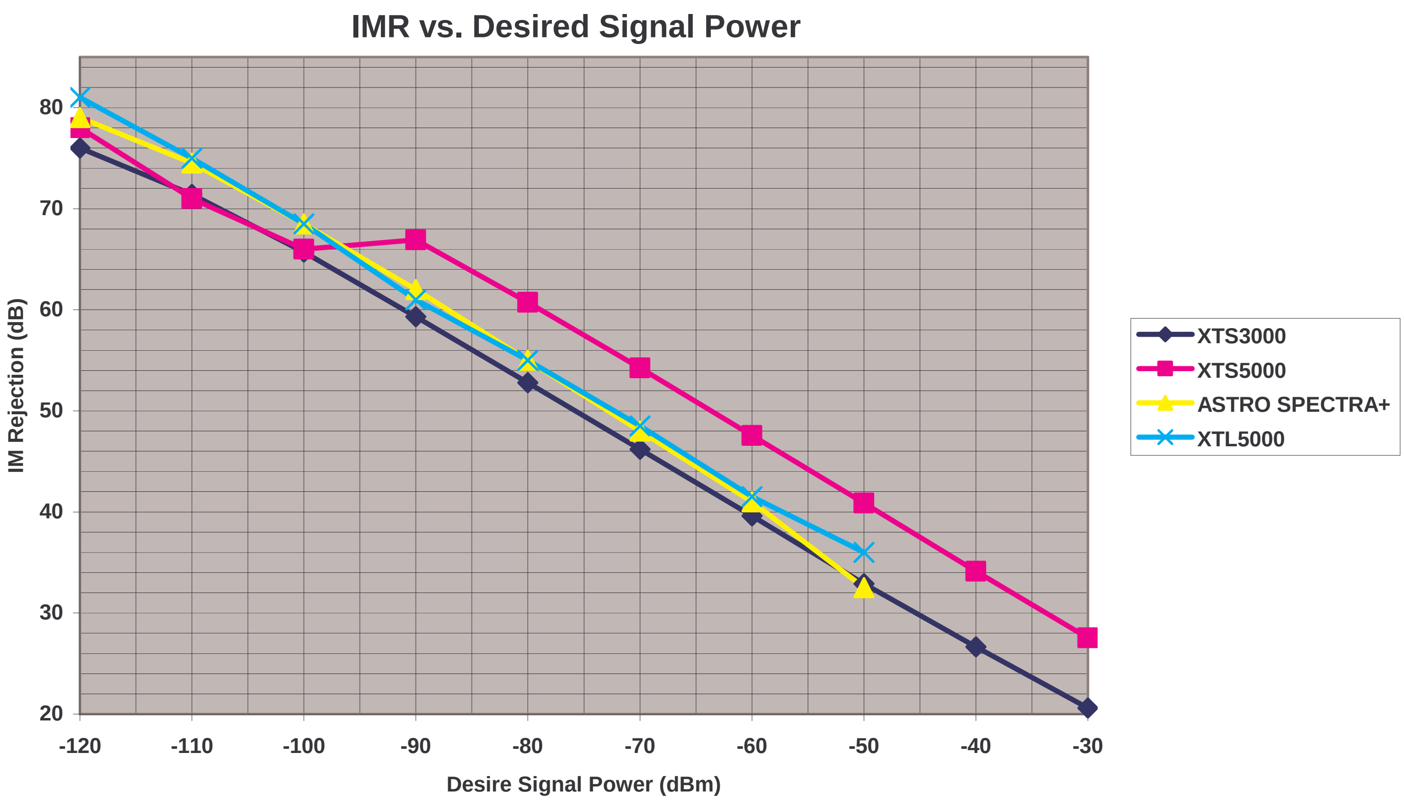

Figure 2

Field Testing:

Motorola has very recently begun field testing of radios with modified software for detuning the front end filters as well as radios with switchable attenuators. Motorola has conducted this testing on customer sites with little customer involvement because of the newness of the technology. However, customer testing and certification of the results is in progress. This testing focuses on several areas including, evaluation and enhancement of the decision algorithm, qualitative performance of the attenuator and detuned front-end filter, and some feature interaction. Following is a brief summary of current, in progress, testing and our earlier findings.

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1) Anne Arundel County– The 700/800 MHz dual-band radios having a wider front end characteristic are more susceptible to energy from the cellular 800 MHz bands than the older generation 800 MHz only radios. This has led to interference at some customer sites that was not present from previous generation radios. Testing with switchable attenuator and retuned front end has shown that both of these implementations mitigated this interference. Beta testing of retuned front-end software upgrade is planned to begin in May 2003.

2) Columbus, Ohio – The situation is similar to that experienced in Anne Arundel county and similar improved results were experienced. In addition, at two sites we found that the 700/800 MHz dual-band radios with modifications did have better audio performance than the existing 800 MHz only radios. Beta testing of retuned front-end software upgrade is planned to begin in May 2003.

3) Sacramento Metro Fire Department –The fire department has been unable to communicate with existing radios in a "tank-farm" area due to interference. With the modified 700/800MHz dual-band radios communication was possible in the tank-farm where it was not possible before.

4) Phoenix/Mesa: This is a new Motorola system that is being installed and has not yet been turned over to the customer. One site in east Mesa was found to have interference from CMRS sites. Testing with radios with retuned front-end software and radios with switchable attenuators eliminated the interference found at this site.

5) Washington County – This was one of the earliest cases of interference. This testing incorporated unmodified MTS2000 portables, modified MTS2000 portables[23] and portables with switchable attenuators. At the test location, the unmodified MTS2000 would not receive or function in any Trunked mode. The modified MTS2000 functioned in all scenarios, but only marginally, it would break up and be noisy and occasionally lose a channel assignment in Trunking mode. The portables with the switchable attenuator worked perfectly in all scenarios, there was negligible noise on desired signals and Trunking mode functioned normally.

These results are largely qualitative, but demonstrate a marked reduction in intermodulation interference. Motorola is in the process of developing more quantitative test information and is dedicated to moving forward aggressively on testing products with the solutions discussed above to quicken commercial availability. Motorola plans to begin beta testing with customers as early as May 2003 and to have the switchable attenuator solution available in commercial products by the end of 2003.

[23] Modification defined by SRN1347 to address a non-linearity in the MTS2000 intermodulation rejection. See letter from Terry Mansfield to Solomon Satche dated April 30, 2003, with SRN1347 attached.

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III. Revised and Forward Looking Best Practices for Avoiding Interference

a. Revised Best Practices

Motorola believes that an updated set of best practices, incorporating the technical advances described above, provides a foundation on which to address interference to public safety in the 800 MHz band.

The current best practices guide calls for a number of steps to be taken, including retuning CMRS channels away from public safety operators channels; modifying CMRS power levels, antenna height and antenna characteristics; assuring proper operation of base station equipment; and improving the local signal strength of the public safety communications system.[24] With the availability of advanced receiver designs, Motorola now recommends that the best practices guide be modified to include deployment of enhanced receivers in areas where the public safety signal strength is sufficient to support their use. Accordingly, where interference cannot be otherwise resolved, the public safety signal strength would need to be evaluated and deployment of new receivers would be included in conjunction with a plan to improve the public safety signal strength, if necessary, to improve the overall performance of the public safety system.

Motorola notes that rebanding the 800 MHz band does not eliminate the need for best practices. The consensus parties recognized this and included recommendations for revising the current best practices guide to include improving out-of-band emissions for CMRS systems, improving the signal strength of public safety systems, and ensuring that public safety receivers are compatible with the newly defined operating environment. Motorola agrees with this approach and, as stated in our previous comments, recommends that the industry work together to fully define the radio environment in which radios are expected to operate. This will provide a clear target for radio performance requirements while providing flexibility for manufactures to meet these requirements as effectively as possible.[25]

b. Forward Looking Best Practices

It is important that best practices not be focused on reactive procedures to address interference after it occurs. Public safety communications must not be compromised with only the promise of working to solve the problem after the fact. Accordingly, a key part of best practices should be for public safety and CMRS operators to work together to identify areas or situations where interference is likely, and to address the problem before it occurs. As recommended by the consensus parties, best practices must include agreed methods for measurement procedures and procedures for predicting

[24] Best Practices Guide at 11-14.

[25] Comments of Motorola, Inc., February 10, 2003, at 18-19.

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interference. The best practices guide should establish procedures for when parties must conduct an analysis and the type of information that must be provided. It is only through a collaborative effort that interference will be successfully controlled.

c. Benefits of Best Practices – Limited disruption and Limited Expense

Interference to public safety must be addressed as efficiently and effectively as possible, and in a way that minimizes disruption of services. A revised best practices approach has the advantage of limiting disruption to only those systems and areas experiencing or likely to experience interference. While interference is serious when it occurs, the record indicates that it is occurring in a relatively small number of systems compared to the total number of public safety systems. A review of the APCO database on interference shows 24 unique customer issues in 2000, 7 in 2001, 23 in 2002, and 5 in the first quarter 2003. This is compared to a total of 2,139 public safety systems deployed at 800 MHz Accordingly, focusing on these areas makes sense, provided that long-term mitigation is possible. Enhanced public safety receiver performance, and increased public safety signal strength provides such long-term mitigation. Regardless of whether these changes are made in addressing an individual case of interference, overall improvements will be incorporated by public safety over time as equipment is replaced. Best practices therefore offer both a quickly available short-term solution and a long-term solution.

IV. Conclusion

Motorola is pleased to provide the FCC with updated technical information related to resolving interference to public safety in the 800 MHz band. Advances in radio receiver design, combined with an agreement by user representatives that increased signal strength should be part of a solution, make a technical solution to resolving interference in the 800 MHz a viable option.

While Motorola is still in the process of testing new receivers, the results of testing to date are very promising. Advanced receivers would successfully mitigate interference in a number of instances where it has occurred. The addition of switchable attenuators brings the performance of portable radios, in areas of sufficient signal strength, to levels exceeding current TIA Class A mobile radios, and Motorola is not aware of any reports of interference to mobile radios which meet the TIA Class A specification. Based on these results, Motorola believes that a technical solution, based best practices offers both a long-term and short-term solution for addressing interference. Coordination between CMRS and public safety will provide a viable mechanism for preventing interference before it happens.

Because a technical solution can be focused on areas where interference occurs or is likely, this approach avoids widespread disruption to public safety operations. Motorola would welcome the

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opportunity to work with the Commission to further refine such an approach and to provide additional information as testing continues.

Sincerely,

/s/ Steve B. Sharkey

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